

# Acute Phototoxic Retinopathy due to Infrared Heater

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## ABSTRACT

Although infrared heaters (IRH) are commonly seen in the daily life, ocular complications due to IRH have been reported rarely in the literature. In this case, we aimed to present acute retinal phototoxicity due to IRH exposure which has not been presented in the literature so far. A 24-years old man presented to our clinic with visual impairment in his left eye after exposure to the IRH for approximately 3 hours at a distance of 0.5 meter from left side of his face. Ophthalmic examination findings were normal in his right eye. The visual acuity of his left eye was 8/10 and there was loss in hyper-reflectivity of the ellipsoid zone under the fovea on the optical coherence tomography (OCT). In control visit on month 4, visual acuity was improved to 10/10 in the left eye and OCT findings returned to normal. Our case is the first case regarding the development of acute macular damage due to IRH in the literature. The IRHs used for heating purposes should be used cautiously since they may cause retinal damage.

**Key Words:** Phototoxicity, Infrared rays, Optical coherence tomography, Retinal pigment epithelium, Retinal photoreceptor cell outer segment.

## INTRODUCTION

The infrared heaters (IRHs) produce heat via electromagnetic radiation at infrared wavelength.<sup>1</sup> Although IRHs are commonly used for space heating, they are also used in many fields such as medicine, industry, research laboratories, dye drying and thawing frozen products.<sup>2</sup>

In the literature, albeit rare, it was shown that macular damage can develop due to infrared electromagnetic radiation by acute or chronic exposure to sources such as laser pointers or arc weld. However, acute retinal injury due to IRH has not been reported so far.<sup>3-6</sup> Here, we aimed to present clinical characteristics and optic coherence tomography (OCT) findings in a case with history of phototoxic retinopathy caused by infrared radiation. The patient gave informed consent for sharing test results and information for academic purposes.

## CASE REPORT

A 24-years old man presented to our clinic with impaired vision in left eyes. In the history, it was found out that he experienced vision problem following IRH exposure

to his left side from 0.5 m distance in an entertainment venue. The patient reported that he did not directly look at heater and that exposure lasted over 3 hours. There was no additional systemic and ocular disease.

There was no history of drug or psychostimulant substance use during this period. When technical specification of heater was reviewed, it was seen that the device is an IRH (220 V, 50 Hz, 2000 W) that produces heat via infrared radiation.

In ophthalmologic examination, best-corrected visual acuity (BCVA) was 10/10 at right eye and 8/10 in the left eye. Intraocular pressure was normal in both eyes and no pathological finding was found in anterior chamber examination. In funduscopy, right eye was found to be normal but an alteration in reflectivity of left eye (Picture 1A and 1B). On OCT, right eye was normal but there was loss of hyper-reflectivity at ellipsoid zone under fovea and mild retinal pigment epithelium (RPE) injury in the left eye (Picture 1C and 1D). No abnormal finding was detected in fundus fluorescein angiograph and fundus auto-florescent imaging. Based on history and available findings, the patient was diagnosed as macular injury caused by IRH. Topical prednisolone acetate (1%, 5x1 over a month)

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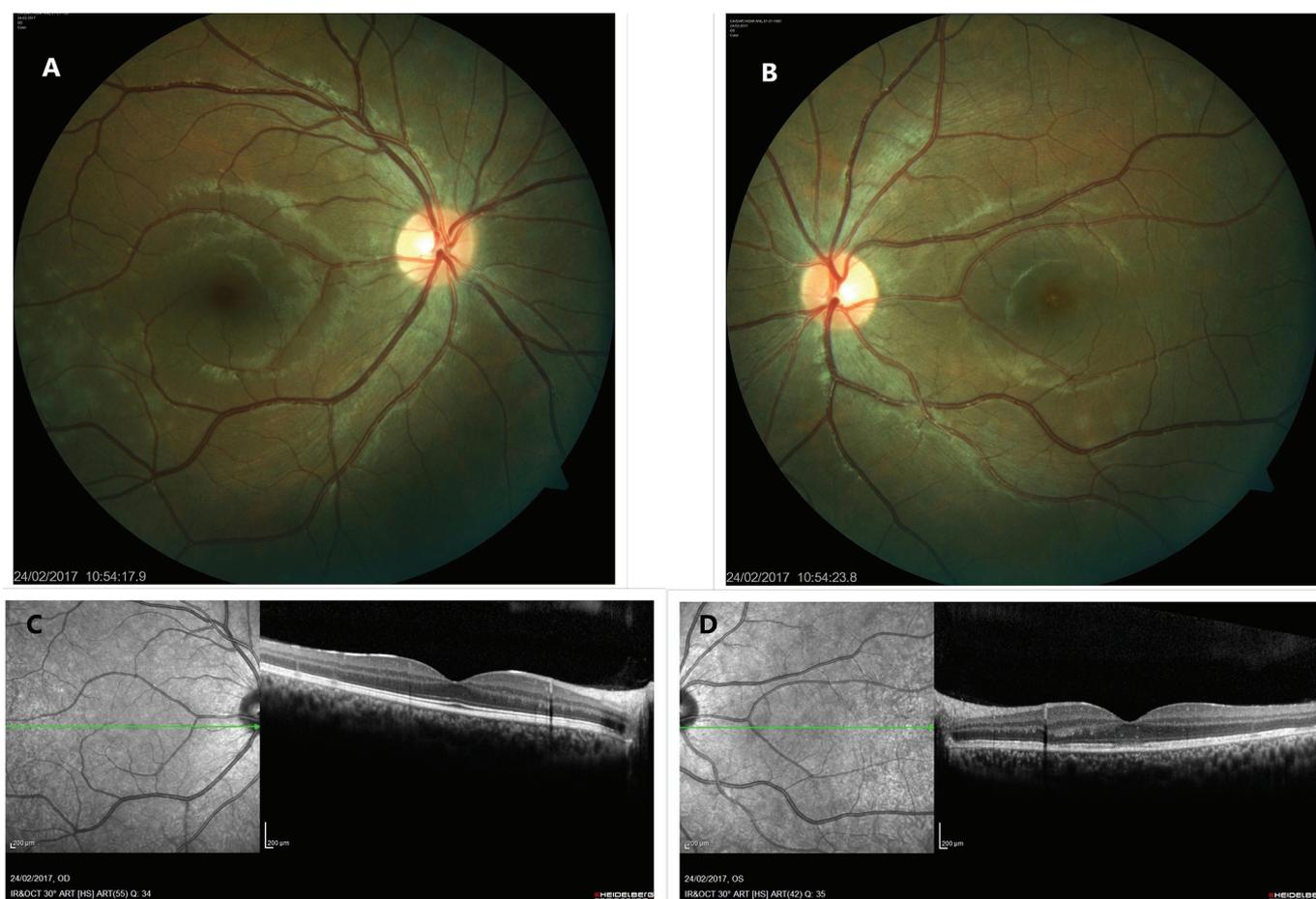
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**Picture 1.** Fundus (above) and optic coherence tomography images (below) of both eyes at initial examination of the patient who presented with decreased vision due to infrared heater in left eye; A) Normal findings in right eye; B) Altered foveal reflectivity in the left eye; C) Normal findings in right eye; D) Irregularity in outer retinal segment at fovea and loss of hyper-reflectivity in ellipsoid zone and mild injury in retinal pigment epithelium in left eye.

was prescribed to the patient. No treatment-related complication was detected. In the control visit on month 1, BCVA was remained as 8/10 in left eye and there was mild improvement in OCT findings (Picture 2). On the follow-up without treatment, BCVA improved to 10/10 in left eye on month 4 and OCT findings were regressed (Picture 3).

## DISCUSSION

The electromagnetic radiation with wavelength of 380-760 is defined as visible light while those with 10-400 nm as ultraviolet radiation and those with 700 nm-1 mm as infrared radiation. According to International Commission on Illumination (CIE), infrared radiation is classified into 3 subgroups: 1) IR-A: infrared radiation with wavelength between 700 and 1400 nm; 2) IR-B: those with wavelength between 1400 nm and 3000 nm; and 3) IR-C: those with wavelength between 3000 nm and 1 mm.<sup>7</sup>

The IRHs transferring heat via electromagnetic radiation at infrared wavelength has IR-B and IR-C radiation (1400

nm-1 mm) by 56%, IR-A radiation (760-1400 nm) by 42% and visible light (400-760 nm) by 2%.<sup>2</sup> It was shown that visible light and infrared radiation up to wavelength of 1400 nm reach to retina and can be toxic.<sup>1,2</sup> There is no legal criterion for potential visual hazards caused by IRH use.

Light-induced retinal toxicity can occur via thermal, mechanical and/or photochemical route.<sup>4</sup> Wavelength, energy and duration of light reaching retina are effective in the development of retinal injury.<sup>4, 8</sup> Although pathophysiological mechanism underlying retinal injury due to infrared radiation hasn't been fully elucidated, it has been proposed that retinal injury results from free radicals produced in retinal cells and it was shown that toxic effect leads photoreceptor cell death and injury in outer retinal layer by histopathological examination.<sup>9</sup>

In the literature, ocular injuries due to infrared laser have been reported as maculopathy cases developed in arc welding workers and as retinopathy cases due to sunlight



**Picture 2.** Red-free fundus image and optic coherence tomography (OCT) image at control visit on month 1; A) Normal findings in right eye; B) Slight improvement when compared initial OCT findings.

exposure.<sup>3-6</sup> In a study on arc welding workers by Yang et al., it was found that there was pathological appearance in 29.8% and OCT findings in 38.0% of cases after chronic infrared radiation exposure. Authors suggested diagnosis can be made earlier by OCT. In that study, IS/OS band defect and RPE injury were shown by OCT. In our case, ellipsoid zone (formerly known as IS/OS band) defect and mild RPE injury was detected in agreement with literature. In retina, melanin absorbs photo thermal energy most effectively and it is abundantly present in RPE cells. Thus, first evidence for thermal injury is seen RPE cell layer.<sup>9</sup>

Another determinant for retinal phototoxicity is exposure

time to electromagnetic radiation. Zheng et al. reported a case having similar characteristics with our case; however, a chronic IRH exposure (over 2 months) was reported on contrary to our case [6]. Ellipsoid zone and RPE injury was detected in our case and in the case reported by Zheng et al. It should be emphasized that duration of infrared radiation exposure was limited to 3 hours in our case; however, daily exposure of 2 hours over 2 months was reported in the case report by Zheng et al. Thus, our case is the first report about acute retinal phototoxicity caused by short-term IRH exposure. Another important difference is that retinal injury was still detectable on OCT on month 10 in



**Picture 3.** Red-free fundus image and optic coherence tomography (OCT) image at control visit on month 4; A) Normal findings in right eye; B) Improvement in outer retinal layer, ellipsoid zone and retinal pigment epithelium injury. Near-normal retinal anatomy can be seen.

former while OCT findings were completely regressed on month 4 in our case. Available findings suggest that short-term, intensive infrared radiation exposure at close range can cause temporary retinal injury while chronic exposure can cause persistent retinal injury.

Poppers Maculopathy should be kept in mind in the differential diagnosis of retinal phototoxicity. Popper is a general term for alkyl nitrite-based, volatile products used for vasodilatation, muscle relaxation, analgesia and as psychostimulant causing euphoria and sexual stimulant.<sup>10</sup> It is ingested via inhalation and leads vasodilatation by causing nitric oxide release. In the literature, first case

was reported in 1999 by Fledelius.<sup>11</sup> In previous studies, decreased visual acuity in both eyes, visual symptoms such as central scotoma or distortion, yellowish lesions localized at fovea at fundus imaging, impaired ellipsoid layer on OCT, micro-hole formation and vitelliform-like lesion were defined.<sup>12, 13</sup> Although pathophysiology of Poppers Maculopathy with clinical symptoms and findings mimicking retinal phototoxicity hasn't been fully understood, one mechanism proposed is photopic injury secondary to photosensitivity caused by nitric oxide; the similarity of these diseases has been previously discussed in the literature.<sup>14-16</sup>

We excluded Poppers Maculopathy since there was no substance use in detailed history of our case and unilateral retinal injury was shown at side of IRH exposure.

Although there is no established treatment for phototoxic retinopathy, follow-up and prevention from insult are recommended in these patients. Since improvement was reported in visual acuity in a patient received subtenon steroid therapy and in order to suppress potential inflammatory processes in phototoxic retinopathy, topical prednisolone acetate (5x1 over a month) were prescribed to the patient [17]. Although positive response to topical steroid was due to lack of RPE injury and relatively milder ellipsoid zone injury in our patient, there is a need for controlled studies with larger sample size.

The IRHs, commonly seen in daily life, can cause retinal toxicity by chronic exposure; however, it can lead acute retinal toxicity in case of intensive exposure at close range as it was the case in our patient.

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